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Title

Towards a Material Politics of Socio-Technical Transitions: Navigating Decarbonisation Pathways in Malmö

Abbreviated title

A Material Politics of Socio-Technical Transitions

Abstract

As the politics of climate change shift from the design of international institutions to the pursuit of decarbonisation across multiple sites, researchers are increasingly calling attention to the geography and politics of transitions. We suggest that recent work has so far been limited by its rather incongruous focus on power as a capacity held by individual agents on the basis of the resources which they command, such that the material and relational aspects of socio-technical systems and their dynamics are neglected. In this paper, we bring critical political geographical perspectives to bear on the question of the politics of decarbonisation. Recasting decarbonisation as a matter of political geography then opens up questions of its socio-spatial configuration, its indeterminate and provisional nature as well as the ways in which decarbonisation politics are socio-materially constituted. In Malmö, a city renowned for its attempts to direct urban development towards low carbon futures, we find that decarbonisation is enacted through practices of legibility, demonstration and agreement. These serve to navigate particular junctures and form new socio-material connections and realignments between carbon, capital and infrastructure. We suggest that pathways to decarbonisation are not going to be created by any kind of linear blueprint but through processes that allow them to realign and reorder socio-material relations in new sites and domains across the urban fabric.

Keywords

Decarbonisation, socio-technical transition, materiality, politics, socio-material connections, climate change

Towards a Material Politics of Socio-Technical Transitions: Navigating Decarbonisation Pathways in Malmö

1. INTRODUCTION

When climate change emerged as a political problem, its similarity to other issues – such as ozone depletion, acid rain and marine pollution – meant that it was initially conceived as a challenge for collective action in the international arena (Bulkeley 2005). Mitigating climate change was conceived essentially as “an emissions reduction problem” similar in kind to other forms of pollution control (Shaw 2011: 744). From this starting point, analysis has concentrated on how, why and by whom greenhouse gas emissions should be reduced and the relative merits of different policy instruments, mechanisms for behavioural change, and principles of justice for achieving these ends. On-going critique from within political geography and the critical social sciences more broadly concerning the limitations of such an understanding of climate change politics have to date held relatively little sway (Castree 2014).

Yet, over the past decade an alternative frame has emerged – that of the imperative for a low carbon transition or for the decarbonisation of the economy. Rather than being a matter of controlling pollution at the end of pipe, decarbonisation foregrounds climate change as a systemic challenge related to the current dependence of energy systems, transportation and consumption on carbon (Shaw 2011). The roots of decarbonisation can be traced to parallel processes of policy change, including the Royal Commission on Environmental Pollution’s report *Energy in a Changing Climate* and the subsequent take up of the idea of long-term transformation of the energy system in UK policy (Owens 2010). The 2001 *Fourth Dutch National Environmental Policy Plan* adopted a transitions approach to achieve a 40–60% cut in carbon dioxide emissions by 2030 compared with 1990 levels (Kern and Smith 2008: 4093). Similar radical targets for shifting away from carbon-based economies have been advanced by a multitude of actors, from the European Union and national governments, to the State of California, multiple global cities and transnational organisations (Söderholm et al. 2011; Wiseman et al. 2013). Insights into how such large scale transformations in the economy might be achieved have been derived both from three primary fields of inquiry, creating different approaches to what *pathways* to decarbonisation might involve (Rosenbloom 2017). Reviewing the now burgeoning literature on low carbon transitions and decarbonisation pathways, Rosenbloom (2017) finds that pathways are conceived in either biophysical, techno-economic or socio-economic terms. While bio-physical concepts of pathways are primarily derived from the community that has sought to develop scenarios through which atmospheric GHG emission levels can be controlled and particular targets attained, techno-economic approaches tend to foreground the roll out of particular technologies and their uptake as the means through which the steps to a low carbon future can be forged. The socio-technical perspective, in contrast, has directly sought to counter any sense that low carbon transitions are simply a matter of the roll out of technology or the deployment of particular policy instruments, pointing instead to the significant inertia in existing socio-technical configurations and the complex work involved in fostering transitions towards sustainability.

Across the social sciences, it has been this later conception, of socio-technical transitions that has gained purchase, so much so that it is possible to suggest that “we are all socio-technical now” (Bridge 2018: 13).

Yet despite the rapid growth of research on transitions, multiple interrogations of the concept and a proliferation of explorations of the dynamics taking place in different cases, there has been surprisingly less critical scrutiny of the notion of the *pathways* that such transitions are assumed to create (Rosenbloom 2017). As Rosenbloom (2017) makes clear, while the notion of decarbonisation pathways provides an important bridging concept between different approaches and disciplines, as well as between research and policy communities, there are multiple meanings at work in the articulation of decarbonisation pathways. While agreeing with Rosenbloom's analysis that it is important to distinguish the different types of pathway being imagined (in terms of emissions reductions, technological roll out, or changes to the configuration of socio-technical systems), we suggest that it is also vital to attend to the ways in which the notion of pathway can stand for different kinds of entity, in turn create distinct understandings of the ways in which decarbonisation can (and cannot) take place. Reflecting definitional differences, the notion of pathway is variously interpreted as a fixed route, marked and clearly signposted that should be taken or has been followed in order to reach a decarbonised economy or as a sequence of changes that take place in an ordered manner, akin to a form of 'chain reaction'. In either case, the pathway is an entity – a route or sequenced reaction. At the same time, the notion of pathway is used to convey a process such that pathway becomes an active term, a verb to describe a particular course of action followed in order to understand and analyse the work involved in creating low carbon futures. This conflation of the notion of a decarbonisation pathway as both an entity (the route or chain that is followed) and as a process (the way in which the path is forged) has, we suggest, blunted its analytical value. With the fixed route or sequenced reaction notion of pathways in mind, research has tended to focus on those processes that are imagined to take place within these given tracks, rather than to examine, for example, the ways in which pathways are forged, carved out from existing landscapes, taken up, embedded and given meaning. Recent work on the importance of recognising that pathways are not smooth or necessarily pre-given points to the increasing interest in the field in opening up this notion to more critical scrutiny, whether it be by paying attention to the critical junctures and windows of opportunity for decision-making (Rosenbloom 2017; Rosenbloom et al. 2018) or "how contingency, contestation, and justice can affect decarbonisation pathways and create a series of obdurate challenges that can overcome even the best of intentions. (Sovacool 2017: 570; see also Bridge 2018). Here we argue that insights from the socio-technical perspective on decarbonisation pathways coupled with a relational conceptualisation of power and agency can further elucidate the processes of *wayfinding* through which pathways are forged. In line with Barnett and Duvall (2005: 9) we emphasize how power does not have to be thought of as an attribute of particular actors and their interactions (as is common in the literature on the political economy of transitions), but as a social process constituting actors as social beings, that is, their capacities and identities. In adopting this perspective, we are interested in understanding decarbonisation not in its absolute sense (whether or not decarbonised economies are created) but in the political work of seeking decarbonisation: of decarbonisation as a set of politics, social and material relations that are invoked and pursued through a complex array of interventions with multiple intentions and (unintended) consequences.

It is in this sense that our paper examines the emergence of decarbonisation pathways – as a logic and practice of wayfinding that is pursued with the intention of realising a response to climate change but is always bound up with other entities, goals and interests. While the transition studies community has

increasingly focused on political, social and economic dimensions of transitions, recent critiques suggest that the analyses of these dynamics have been relatively underdeveloped in terms of their treatment of both geography and politics (Baker et al. 2014; Bridge et al. 2013; Bridge 2018; Calvert 2015; Power et al. 2016; Rosenbloom 2017; Rosenbloom et al. 2018). In his recent intervention on the spatial turn within the energy social sciences, Bridge (2018: 11-12) reminds us that ‘the map is not the territory’: while a sufficiently coherent set of perspectives and approaches is emerging to create a conceptual ‘map’ of what it means to think spatially about energy and low carbon transitions “the territory is richer and more rewarding than suggested by the current map ... [such that] further adventuring is both possible and necessary if the full possibilities of a spatial perspective are to be realized.” Here, our aim is to contribute to this further exploration, arguing that recasting decarbonisation as a matter of political geography has three profound consequences for the kinds of conceptual and theoretical avenues that need to be developed. First, we need an account of the whereabouts of the political that shifts from the familiar terrains of the global, national or local, but instead draws attention to how new socio-spatial arrangements are being established through decarbonisation. Some geographical work has started to explore these dimensions. Using a Foucauldian socio-material conception of governmental power, Bulkeley et al. (2013) show how responses to climate change take root across urban infrastructure networks (e.g. energy) and are conducted through a range of experiments (pilots, innovations, demonstrations). McGuirk et al (2015) study of urban carbon governance, show how very diverse elements, from inefficient air conditioners to the economics of electricity production, are drawn and held together through common processes and particular social and material devices (storylines, forms of ordering). Dalby (2013) draws attention to a neoliberal geometrics that call “all sorts of new ecological entities into existence as matters for geopolitical calculation” (Dalby 2013: 43) while Aiken (2016) show how the state’s calculative logics force its way onto community based low carbon transition movements, changing questions around organising and belonging. Most recently, McEwan (2017) shows how renewable energy transitions are simultaneous spatial and political processes that take shape through ‘zones’ of political-administrative exceptionality (territories) that allow particular actors to exercise authority and commercial power. Such accounts unsettle the familiar political territories of accounts of low carbon transitions and require that we examine how instead the reconfigurations of power that accompany decarbonisation are at once spatially manifest (Allen 2003).

A second consequence of opening up decarbonisation to political geography is that the temporal and spatial characteristics of transformation itself come to the foreground. Indeed, as recent accounts within the transitions studies field have suggested, decarbonisation pathways are far from unilinear and directional but may instead be rather indeterminate (Geels et al. 2016a; Turnheim et al. 2015; Sovacool 2017). This requires in turn that our understanding of the workings of power and its politics are also less determinate, more provisional and open to different forms of possibility. Here, Haarstadt and Wanvik (2016) suggest that geographical accounts of energy and low carbon transitions need to be wary of being too resolutely concerned with the dynamics of ‘lock-in’ and inertia and instead need to account for the on-going work of maintaining stability and the ever-present possibilities for disruption and novelty. Third, and related, we suggest that rather than seeing the politics of transitions as operating separately to their socio-technical constitution, recasting decarbonisation in geographical and political terms creates space to explore new perspectives on how power and agency are socio-materially constituted.

Our purpose in this paper is to develop a novel perspective on low carbon transitions and decarbonisation pathways that account for their socio-spatial configurations, indeterminate and provisional nature as well as how their politics are socio-materially constituted. In order to develop such a perspective, we move beyond existing approaches within the socio-technical perspective on decarbonisation pathways that tend to account for power as an attribute of particular actors to affect transitions and achieve particular outcomes (Avelino and Rotmans 2009; 2011; Geels 2014). Power has within this field of transition studies been seen as a property held by particular actors or institutions and deployed at particular moments. On the contrary, our perspective is founded on a relational account of power where power is not pre-given, or held, but generated through the ways in which entities become configured in relation with one another (Allen 2004; Barnett and Duvall 2005). Our contribution to the study of decarbonisation transitions is to draw attention to structural and productive dimensions of power, where the capacities of actors are socially produced, and where the perceived interests of actors are generated through the (social) processes that actors are engaged in. The growing scholarly interest in 'transition pathways' is apt for developing our perspective. The pathways concept indicates a shift in the understanding of transitions, from being linear and directional to context dependent and evolutionary (Turnheim et al. 2015). Governing a 'decarbonisation pathway' is thus less about 'control' but more about how they are assembled and congealed through particular arrangements. In contrast to writings within the transition studies literature, we advance a relational account of decarbonisation pathways, where power is an historical, emergent and immanent force. Our analytical task becomes one of seeking to understand how and why particular kinds of socio-material relations are assembled, held together and create momentum through the productive capacity to generate power and the ways in which this is contested.

Following Rose (1999), Li (2007a) and Barry (2013) we conceive of government in assemblage terms, where the will to govern is realised through the combination of heterogeneous elements (e.g. practices of calculation, types of authority, architectural forms, non-human objects and devices). Walters (2012: 77), drawing on Rabinow (2003), points to the fluidity, experimentality and (possible) ephemerality of assemblages. They are 'precarious achievements' (Graham 2010: 11). In line with Li (2007b: 25), we emphasize that there is a multiplicity to power, it enables as much as it constrains or coerces. Some practices render power visible and trigger conscious reactions (e.g. resistance, accommodation, consent), but some modes are more diffuse as are peoples reactions to them. When power is multiple, it cannot be totalizing and seamless. Recent work within the transitions studies literature draw attention to the multiplicity of pathways and the importance of critical decision-making junctures (Geels 2016; Rosenbloom 2017, 2018; Sovacool 2017; Bridge 2018). These junctures are often understood as a choice between one or more 'branches' emphasizing that pathways can develop in multiple directions. While such kind of thinking has opened up the idea of pathways as multiple, it tends to think of them as predetermined, which we consider reducing an understanding of the political possibilities and forms of power/agency at work in the making of pathways. In the case of Malmö, as will be shown later, sustainability played only a peripheral role when Malmö early on tried to imagine a plausible positive post-industrial future. The idea to make the housing fair, which was in the early planning stage, revolving around sustainability came from people working outside the city of Malmö. Sustainability was, however, picked up and realigned by the planners to be decisively urban instead of revolving around 'eco-villages' (N.N. member of the Malmö city planning office). Since then, the story of the transformation of the area is often

told symbolically through reference to two tall vertical objects. Turing Torso, a 186 m high residential building, is placed on the site of the old Shipyard (Kockums) crane, which was finally dismantled 2002 and sold to Korea.

From Jensen et al's (2016) account of the transition of Copenhagen's waterways, we use the idea that pathways are shaped by 'navigational actions', a term that denote how actors encounter specific unstable junctures in the urban fabric that needs to be addressed or improved. The success of the work of navigation relies on the emergence of mediators that translate and enrol different kinds of entities. We develop our perspective on decarbonisation transitions through engaging with Malmö, a city renowned for its attempt to direct urban development toward low carbon futures. We identify three key practices through which the navigational politics is conducted; 'legibilization', 'demonstration' and 'agreement'. First, rendering legible is a calculative or aesthetic way of coding, representing and knowing a domain, thus making it possible for government to operate. Second, demonstration is about arranging particular socio-material relations (e.g. housing, mobility, energy provision, shopping) within the narrative of a low carbon transition. Bringing into *agreement* is about piecing together a bricolage of diverse entities — thereby enabling socio-material relations to reconfigure. Together these concepts allow us to pursue an innovative perspective on the politics of decarbonisation pathways where instabilities and fluidities matter, and where pathways are formed and energised through new connections and realignments between carbon, capital and infrastructure at particular junctures. Assemblages are never simply a realisation of a programme, strategy or intention, but the will to govern traverses them (Rose 1999: 52). The material politics of decarbonisation pathways that we identify is navigational and not directional. It's a bricolage as diverse sites and domains are enrolled through new socio-material configurations.

The paper is ordered as follows. In section 2 we outline how the material politics of transitions have been conceptualised and how our approach is different. Here we first outline how existing approaches to socio-technical transition have framed the dynamics of change, before considering how alternative perspectives that focus on questions of socio-material assemblage and the working of power through socio-material orders can provide alternative insights. Drawing on these perspectives, the paper then turns in section 3 to examine the politics of decarbonisation in Malmö, where we examine how decarbonisation is navigated and enacted through, in turn, the socio-material practices of legibility, demonstration and agreement. In the conclusion we suggest that pathways are not going to be created through any kind of linear blueprint. Pathways are the result of emergent processes as they realign and reorder socio-material relations in new sites and domains across the urban fabric.

2. CONCEPTUALISING TRANSITION POLITICS

The field of transition studies has emerged to explain stability and change within the socio-technical systems through which societal functions (e.g. energy, mobility or water) are provided. With roots in the study of large-technical systems, the social construction of technology and innovation studies, this loosely affiliated body of work draws attention to the mutually co-dependent relationship between material infrastructures, technical entities, social institutions and norms. As Jensen et al. explain:

“a large-scale system is portrayed as a configuration comprising social and technical elements ... [which] evolves into a regime as the various elements are adapted to one another over several decades. A series of strong reciprocities are forged across system components through this process: user expectations and practices are, for instance, mirrored in the material design of infrastructures, which are again reflected in regulations, standards, investment strategies, professional capabilities and cognitive frames.” (Jensen et al. 2016: 236)

One prominent approach is the multilevel perspective on systems in transition, which suggests that stability and change are produced through (dis)alignment between wide ranging pressures at the landscape level, such the emergence of new economic logics or environmental issues, the (in) stability of dominant regimes, and the emergence of innovation within niches that provide protected environments for alternatives to take root and grow (Geels 2002). From an original focus on explaining historical transitions, a growing diverse scholarship on socio-technical transitions has been concerned with understanding the dynamics and potential of transformations for sustainability. Central to this work has been an engagement with the ways in which the socio-technical systems through which carbon is metabolised, particularly those surrounding energy and transport, are transformed in relation to achieving goals of decarbonisation (Kern and Smith 2008; Raven 2007; Verbong and Geels 2007). In so doing, this work has begun to focus attention on the socio-material conditions and dynamics through which decarbonisation is being pursued. For the most part, critiques of the neglect of power and politics within this body of work have focused on the lack of an avowed focus on how power operates within niches and regimes and the forms of political contestation to which any such transitions processes might give rise (Avelino and Rotmans 2009; Meadowcroft 2009; Walker and Shove 2007). In this section, we first review how the field has sought to respond by accounting for how, why and by whom sufficient power resources and political agency are accrued to enable niche innovations and/or destabilise regimes. Despite rejuvenating analyses of transitions, we suggest that such perspectives on power and politics are, perhaps curiously, rather removed from the socio-*technical* roots of transition studies itself. Drawing on recent work across the social sciences, we examine how an account of the material politics of transitions might open up new avenues for inquiry and insight.

2.1 Bringing Politics into Transitions

Early work on the need to consider the politics of transitions critiqued the literature on large-technical systems as being overly structural and descriptive in their accounts, suggesting that “system-level change is, by definition, enacted through the coordination and steering of many actors and resources, whether these are intended or emergent features of transformation processes.” (Smith et al. 2005: 1492). Since this intervention, momentum has built to theorise power as a capacity of agents to effect transitions (Avelino and Rotmans 2009; 2011). This work has taken different forms. There are those seeking inspiration from political economy in order to examine “specific ways in which regime actors, particularly incumbent firms and policymakers, can use power to resist fundamental system change” (Geels 2014: 28). Another strand has engaged institutional theory to detail the ways in which institutional logics and power allocations are translated in particular fields (Fuenfschilling and Truffer 2014: 775). Others have sought to

deploy concepts from policy studies to understand how actors come together in alliances to promote particular transition pathways (Markard et al. 2016: 216). Particularly important has been a growing engagement with how actors seek to legitimise and support innovations while destabilising regimes through the formation of discourse coalitions (Rosenbloom and Meadowcroft 2014; Smith and Raven 2012) and storylines that frame the innovations in a certain light, thereby “actively modifying and integrating claims about content and context” (Rosenbloom et al. 2016: 1278).

Whichever approach is taken, these debates are animated both by questions over how agents outside the regime accumulate sufficient resources to challenge incumbents and by the contestations that emerge between different actors/alliances in the process of transition. There has been less engagement with more structural accounts of power. Despite a nod in this direction, Geels (2014) ultimately determines that the insights derived from neo-Gramscian accounts of hegemonic power are best deployed to understand how and why particular actors are able to achieve particular outcomes rather than to understand the structural dynamics of hegemonic regimes. Indeed, Gillard et al. (2016: 257) suggest that the dominance of systems thinking within transitions studies means that inevitably “the enabling/constraining effects of political structures and socially embedded power relations are undertheorized.” Thus while transitions studies is beginning to engage with the politics of socio-technical transformation, it does so from a specific perspective from which power is regarded as a divisible capacity, garnered through the mobilisation of resources and deployed at particular moments and with specific intentions. In this sense, power and the politics of its contestation is effectively conceptualised as operating ‘above’ the socio-technical system in question. It is a property conceived as held by discrete actors, rather than emergent from the relational configuration of such systems. Agency is limited to individual actors and institutions, or alliances thereof, rather than emanating from the socio-material dynamics with which transitions studies are ostensibly primarily concerned. If and when the material aspects of socio-technical systems feature at all in such accounts of power, they serve as a set of resources – economic or discursive – which are deployed by social agents.

Such an account of power reflects the ways in which transitions studies tend to conceptualise the dynamics of change (and stability). Broadly speaking, transitions are either thought to occur incrementally within the regime or through some form of disjuncture with the existing regime. In the first model of change, actors use their resources to create innovations that work within the existing distribution of power and institutional structures and in aggregate serve to re-orientate the regime. This pattern is evident in what Smith and Raven (2012) term the ‘fit and conform’ model of transition and in variants of the transition pathways, which Geels and colleagues (2016b: 900) term ‘substitution’ and ‘transformation’. In the second model of change, niches might ‘breakthrough’ existing regime structures replacing particular technologies and actor coalitions with new configurations or otherwise through a process of internal contestation produce the reorientation of the regime around new entities and actors. For Smith and Raven (2012) this is a ‘stretch and reform’ model of innovation, while Geels and colleagues (2016) suggest such processes lead to more radical forms of substitution, transformation or reconfiguration. Whichever the perspective on socio-technical change, as either incremental or radical, the explicit consideration of power and politics as a property of actors and central to explaining agency has led to an understanding that transitions “are not teleological and deterministic, but *continuously enacted by and contested between a variety of actors*.”

Both technology deployment and institutions are continuous sites of struggle (Smith and Raven, 2012), as actors argue for or against the effectiveness, costs and desirability of certain technologies, policy goals and policy instruments” (Geels et al. 2016b: 900, emphasis added).

2.2 Reconsidering the Material Politics of Transitions

This necessarily broad brush summary of recent writing in the transition studies field demonstrates (a) a growing recognition of power and politics; (b) an increasing interest in the ways in which the agency for transformation is constituted, and (c) a shift away from any simplistic sense that transitions are inevitable or pre-determined but instead a contested and emergent phenomenon (Geels et al. 2016b; Smith and Raven 2012; Turnheim et al. 2016). This marks a significant maturation of the field and has produced a host of insights about the ways in which actors are positioned and contestation is emerging around decarbonisation transitions (e.g. Funfschilling and Truffer 2014; Markard et al. 2016). Yet there are two significant incongruities in marshalling this particular conceptual mix of an agency-centred view of power, a theory of change as emergent and the notion of socio-technical systems together that open up possibilities for conceiving of the dynamics of transitions rather differently. First, the growing interest in transition *pathways* has served to significantly advance the debate from some of the initial rather singular, linear and directional reading of transitions, to acknowledge that transitions “involve context-dependent evolutionary processes with emergent properties” (Turnheim et al. 2015: 240) and that governing such processes is in turn more a question of ‘muddling through’ than of ‘direct control’ (Turnheim et al. 2015: 247). However this perspective on transition as the result of emergent processes is rather at odds with the reliance on a an instrumental and bounded conceptualisation of power as a zero sum capacity determined by the resources wielded by agents to achieve specific outcomes. More congruous with a theory of change as emergent are those structural and productive approaches to power, which regard it as an immanent force that is constituted relationally (Gillard et al. 2016; Haarstad and Wanvik 2016). In this thinking, power is not pre-given or held, but generated through the ways in which different entities are brought into relation with one another (Allen 2004; Bulkeley 2012; Hajer 2009).

Making this shift to an analysis of power as an emergent, relational and immanent force in turn requires that we consider the configurations through which it is produced. While historically transitions studies have been concerned with socio-*technical* systems, the second significant incongruity in the current orthodoxy of understanding power relations as agency-based is that this has served to side-line the traditional concern with the *material* configuration of such systems and their dynamics. However, across the social sciences, as Barry (2013: 1-2) argues, there is growing recognition that we can no longer “think of material artefacts and physical systems such as pipes, houses, water and earth as the passive and stable foundation on which politics takes place; rather ... the unpredictable and lively behaviour of such objects and environments should be understood as integral to the conduct of politics.” Rather than regarding the socio-material world in co-evolutionary terms as a “collection of ‘things’ working collectively” this perspective start with the broad understanding that it is comprised of assemblages, precarious achievements of social and material entities that are “ready to untangle at a moments notice” (Graham 2010: 11). As Bennett (2005) argues, assemblage thinking can readily be applied in the context of the kinds of socio-technical systems and infrastructure networks through which carbon is metabolised:

“The electrical power grid is a good example of an assemblage. It is a material cluster of charged parts that have indeed affiliated, remaining in sufficient proximity and coordination to function as a (flowing) system. The coherence of this system endures alongside energies and factions that fly out from it and disturb it from within. ... the elements of this assemblage, while they include humans and their constructions, also include some very active and powerful nonhumans: electrons, trees, wind, electromagnetic fields” (Bennett 2005: 446).

Thinking of pathways to decarbonisation in assemblage terms enables a different reading of their constitution, dynamics and politics as recursively reproduced through the co-constitution of social and material entities. Its not about searching for the grand plans that aims at a total transformation of society (these plans exist, but are uncommon), but the more common programs of intervention that are ‘pulled together from an existing repertoire, a matter of habit, accretion, and bricolage’ (Li 2007b: 6). Interventions that seek to govern socio-material assemblages towards particular ends are precarious, unfolding, and emergent, operating through configuring particular socio-material relations and their dispositions (Li 2007a; Foucault 2009). This suggests that in seeking to understand the politics of decarbonisation we need to attend to the “hard work required to draw heterogeneous elements together, forge connections between them and sustain these connections in the face of tension ... and [how they] might or might not be made to cohere” (Li 2007b: 264).

The political projects of assembling decarbonisation pathways are then both congealed in particular arrangements, but also subject to continual processes of maintenance and re-configuration. In their recent account of the transition of Copenhagen’s waterways, Jensen and colleagues (2016: 557) argue that such work is animated by ‘navigational actions’ as actors encounter specific junctures in the urban assemblage where “the established order and identity of the urban fabric has become unstable.” Navigational actions are undertaken as forms of “sociomaterial repair work aimed at addressing such junctions” and reconfiguring particular urban assemblages. Critical to the success of such endeavours, they argue, are mediators – specific socio-material entities – capable of “translating a series of ambiguous and open-ended sociomaterial boundaries and relationships into a phenomenon that performs as a single and discrete entity” (Jensen et al. 2016: 2015). The generation of such mediators at/through unstable junctures in the urban assemblage forms a critical means through which urban transformations take place, fostering “the enactment of new relationships, boundaries, and reciprocities among the established sociomaterial assemblages of the urban fabric” (Jensen et al. 2016: 2015).

Following this line of argument, the work of navigation, unstable junctures and the emergent formation of particular mediating entities could therefore be critical to the enactment of decarbonisation pathways. For Jensen and colleagues this is a work that takes place in the absence of strategic vision or predetermined forms of intervention, and it is also work that is primarily conceived in terms of (an albeit expanded version of) agency. We suggest that such “micro-political” work is an essential element of how the governing of decarbonisation pathways takes place — a means through which strategic intention is both translated into, and comes to be configured, in the urban milieu. Seen from this vantage point, navigation does not stand in opposition to or in the place of strategy, but helps us to understand the

ways in which such forms of intervention are also precarious, unfolding and shifting achievements that require on-going work in order to be accomplished. One should keep in mind that there is unevenness in the work of configuration and that the unevenness can be thought of in different ways. Approaches within the social sciences derived from e.g. neo-classical political economy highlight fundamental differences between actors such as 'the state' and 'the firm', and tease out the interactions that unfold from such assumption. We, on the other hand, take power to be imminent to the relations through which it is forged, rather than an attribute of particular actors and their interactions. We emphasize how unevenness result from path dependencies as some actors have more power to configure than other because they have accrued that capacity through navigating previous forms of juncture.

In our view, decarbonisation pathways are not set trajectories, but continually in the making. They unfold as diverse elements interact and new possibilities open up on the one hand, and what it is that should be corralled towards low carbon ends overflow particular governmental projects on the other. Here, the analytical challenge is one of engaging with the practices through which decarbonisation is forged, examining the kinds of realignments that these afford, and the forms of politics to which this gives rise. Our reading of transition pathways suggests that decarbonisation is unlikely to travel in simple ways through space or across scale. Instead, the task is one of tracing how the practices that enable the configuration of decarbonisation establish new routes and flows through which new sites, elements and agencies are enrolled and extend the decarbonisation of society. In what follows, we examine the case of Malmö and the emergence of a suite of political projects directed, in some degree, towards decarbonisation and examine the governing processes of making legible, demonstrating and agreement through which pathways of this nature are navigated and enacted.

3. NAVIGATING DECARBONISATION ACROSS MALMÖ

In Malmö, once a thriving industrial city, the combination of global economic shifts (leading to bankruptcy in the critical shipping industry) and changes in population (leading to a fall in tax revenue for the municipality) caused significant decline in the 1980s and early 1990s. Although multiple attempts to reinvent the industrial city were undertaken, by the early 1990s it was clear that a new vision was required for the city. To use the just outlined conceptual vocabulary, this was such a moment when the identity of the urban fabric was destabilised allowing for new alignments to be made. In 1994, the newly elected Mayor, Ilmar Reepalu, initiated "Project Malmö 2000", tasking an eclectic group of eight public officials from various sectors (e.g. education, economy, environment, culture etc.) to formulate a positive future for Malmö in order to achieve economic competitiveness. Presented in 1996 as *Vision Malmö 2015*, the strategy contained plans for the redevelopment of the Western Harbour, the former industrial area of the city, through a housing exhibition (Bo01) and a new university campus. The vision was firmly rooted in the idea of the knowledge economy, with matters of sustainability playing only a peripheral role. Despite this initial focus, as the design and installation of the Bo01 housing exhibition and the reconfiguration of the Western Harbour area took place in parallel to the opening up of transport links to Copenhagen and the iconic Bridge, sustainability emerged as a key means through which to imagine the future city and its development within the Öresund region (Dannestam 2009). Urban sustainability both emerged from the

practice of designing a vision of an urban future and also as a strategic means through which to attract funding for large projects that in turn would facilitate Malmö's branding as an "ecometropole" (Anderberg and Clark 2012).

In the decade following the Bo01 housing exhibition, the Western Harbour district has given rise to multiple sustainable urban development interventions, from energy and heating provision to waste management, which in turn have enabled Malmö to position itself in the context of sustainability and climate change. The list of awards and prizes has subsequently been long¹ and Malmö has received considerable EU support for projects within and beyond the Western Harbour.² Through this work, the general frame of urban sustainability has been repositioned in relation to the potential for imagining "climate smart" urban futures and the focus of attention has moved across the city to the new "Hyllie city district". Malmö's carbon neutral plan and the Climate Contract it negotiated with the local energy company, E.ON, established the development as "the most climate smart city-district in the region" (Climate Contract 2011) making sure that by 2020 the energy provided for Hyllie will be 100 % renewable or recycled (by 2030 the entire Malmö shall be 100% powered by renewable energy). Hyllie is not imagined as a closed-off avant-garde experiment, but as deeply connected to the local and the global; "Close to the world, and close to home" (Climate Contract 2011). Here, the notion of decarbonisation has enabled and been configured through navigating the junctures of economic decline, vacant land, housing exhibitions, shifting regional infrastructures and changing ownership of the systems of energy provision. This emergent pathway was not without strategic intent or the operation of power and politics. Decarbonisation has emerged as strategically important means through which diverse forms of intervention in the city can be corralled, resources generated and often disparate, experimental projects formed into a whole. Our argument is that this work, of bricolage, is the means through which decarbonisation pathways come to be forged. Rather than following a blueprint to clearly demarcated destinations, pathways are the result of multiple encounters, junctures and conveniences, which like the 'desire lines' found across urban space that deviate from the plans of their designers establish and embed particular routes and new forms of path dependency.

Drawing on empirical research conducted in Malmö, we analyse the work undertaken to harness the emergent qualities of particular socio-material configurations in configuring pathways to decarbonisation. The research upon which this paper draws involved extensive analysis of documentary evidence, a series of seven interviews undertaken with key actors in the city who have had a role in different projects across the period of the development of Malmö's decarbonisation pathway (1996 – 2018), and the use of what we term a 'mobile lab' method where interdisciplinary groups of researchers engage in the collective gathering of evidence through various encounters with the case in question, such as meetings, site visits, films, talks, visual representations of future projects and so forth. In this case, we have organised and participated in two mobile lab processes related to Malmö's decarbonisation pathway (April 2014, November 2017) associated with two different research collaborations that have engaged with this case-study (details provided in the acknowledgements). Our intention is not to provide a detailed account of the ways in which decarbonisation has emerged and been contested in Malmö (for excellent accounts, see Madureira 2013; Lenhart et al. 2014; Holgersen and Malm 2015). Rather, we seek to use the case-study to explore how the three dynamics of legibility, demonstration and agreement, which our conceptualisation

of decarbonisation pathways suggest may be vital forms of work undertaken, are more or less present in this instance. We use this analysis to reflect upon the potential value of our argument concerning the need for the development of new approaches which open up the political and spatial dynamics of low carbon transitions.

3.1 Creating Legibility

At the heart of navigating decarbonisation pathways in Malmö is the work of legibility – the art of making decarbonisation apparent in such a way that it can be enacted. Legibility as a concept refers to the quality of being clear enough to be able to be read. As Miller and Rose (1990: 6) argue, “all government depends on a particular mode of 'representation': the elaboration of a language for depicting the domain in question that claims both to grasp the nature of that reality represented, and literally to represent it in a form amenable to political deliberation, argument and scheming.” While shared visions draw agents with different interests together around niche interventions and transition projects (Neuens et al. 2013; Schot and Geels 2008), we want to attend more specifically to how particular visual practices are the socio-material means through which the work of navigational politics is conducted. The practice of legibility is part of a wider suite of governmental techniques that have been conceived as creating the legibility required for government to operate, enabling specific domains to be ordered and the “reality they depicted to be remade” (Scott 1988: 3). For the most part, practices of legibility have been regarded as those that involve technical calculations and their material manifestation such forms of census, standard setting or mapping (Miller and Rose 1990; Li 2007; Scott 1988). Yet recent research suggests that “governmentality can operate as effectively through aesthetic norms as it does through those ‘scientifically rational’ and statistical processes of knowledge assembly widely discussed in the literature” (Ghertner 2010: 186). Such forms of aesthetic become a different way of knowing, in this case decarbonisation, that serve not only to make it intelligible as domain to be governed but also foster forms of attachment and engagement. This is a more than discursive process, as “planners work through physical proxies to approximate their desired objective ... The techniques and rationalities are seldom new. Rather, new objects are created out of the combinations of old elements, creating a chain of equivalences that compound different logics upon each other.” (Lee 2013: 149-150). Making decarbonisation legible, which is central to the pursuit of governance, is then both about creating particular calculations as well as the development of particular aesthetic sensibilities and working through ‘physical proxies’ to bring desired objectives to light. This perspective suggests that accompanying the development of actor visions for sustainability are socio-material manifestations of visibility that enable and enact decarbonisation pathways.

We suggest that creating visibility for decarbonisation pathways, both discursive and material, is a vital political work. The ways in which decarbonisation is made legible will in turn shape the ways it can be navigated and its emergent possibilities. One example from Malmö is the explicit process of *visioning* that took place amongst those concerned with the redevelopment of the Western Harbour area in the early 1990s. In advance of any formal land development or planning process, drawings that sketched out a new urban area, complete with housing, business and leisure facilities, were spread by the planning officials

through the local media. These drawings involved both an act of calculation – representations of the planners’ blueprints for the city – but also sought to foster an aesthetic sensibility and sense of feeling about the city’s future possibilities. These ideas of what the city could become began to gather momentum:

“then we made um big posters putting up all round the city, used all media and in the city hall, in all the corridors in all the big rooms, meeting rooms, we had all those pictures describing the future, the city life the new perspectives the new buildings, instead of a shipyard a new fine part of the city and so on and after half a year you can see people reacting in a new way, instead of pulling down you know the traditional map of Malmö when the politicians or other people were discussing something, they went up to a new perspective of the new city and then they said, you can see the city right behind here that’s where we are now, and they used the future and that’s a mental change “ (N.N. Director of the city planning office)

Rather than adopting dialogic practices to create a shared vision, here the intention was to generate visibility for a city-yet-to-be. It was through its socio-material rendition in meeting rooms, on billboards, in the newspapers – that mattered for opening up the possibilities of the urban juncture of land redevelopment. Through creating visibility for a particular version of Malmö’s urban future, the idea of a modern urban district came to be shared across a range of constituencies in the city. Depicting Malmö as a new urban development at this juncture served not only to draw sustainability – and later low carbon – into Malmö’s urban development, but also to tie the redevelopment of land to the pursuit of sustainability. From the outset, the Bo01 housing exhibition was intended to bring together a range of elements that could stand in for sustainability, from the waterways of English Cotswold Villages and Renaissance Italian Cities, to the close proximity of dwellings in the urban core, and the principles of ecological sustainability derived from eco-villages.³ Derived also from the new urbanist movement that dominated international planning debates in the late 1990s and early 2000s, Western Harbour also drew direct inspiration from the successful Hammarby Sjöstad development in Stockholm as key personnel moved from this iconic project to another.

Representatives from Malmö Planning office (including their appointed architect for Bo01 Klas Tham) and the developers worked together with the developers in an association called ‘The Owners Group’ to create detailed guidelines (‘the Quality programme’) for building on the Bo01 site. The programme contained a master plan that outlined the larger elements (waterfront promenade, the canal, the ‘European village’ and the massing of the buildings) but also a colour scheme and descriptions of material selection, which had to be local and sustainable. Klas Tham, the masterplan architect, wrote a brief piece, ‘Bo01 City of Tomorrow’, for Urban Design Quarterly where he summarises his ideas on how to achieve transformations toward sustainability. ‘The prevailing quantitative standards for environmental sustainability (such as saving energy where the new district will in fact be self-supporting) are necessary, but insufficient. It will not be until people’s aesthetic, emotional and social needs are also met that the sustainable society can be attained. Aesthetic aspirations and gentle care will thus be necessary conditions for tomorrow’s wise building’ (Tham 2004: 14). This is also formulated in the City of Malmö’s Environmental Programme, adopted in 2009 (Malmö 2009). Here, two of the four main goals are that Malmö should be Sweden’s most

climate friendly city and that it should be easy to do the right thing in Malmö. Madureira (2013), in her close examination of the process, argues that through the invoking of a sustainability discourse a new urban aesthetic were able to be advanced. However, in contrast to common sustainability practice, the Bo01 did not involve a wider residential community in the process. She emphasizes how the planning department, despite collaborations within public-private partnerships, were able to control the process through setting the agenda, propose visions and taking the role of a mediator.

Since the completion of Bo01 in 2001, the redevelopment of land elsewhere in Western Harbour and across the city has reiterated these design aesthetics, seeking to make visible the ways in which living a sustainable, low carbon life does not imply compromise in terms of the quality of living. It should, in Tham's words be 'practical, stimulating and pleasurable' (Tham 2004: 15). Perhaps epitomising this is the *Turning Torso*, at the time Europe's largest residential building, erected on the site of the previous shipping crane. While it attracted controversy as a symbol of the exclusive nature of the development, it acted as an important lynchpin in the landscape, visible across the Oresund from Copenhagen drawing the eye dramatically towards the Western Harbour. The Torso has come to symbolise Malmö and its project for urban sustainability and low carbon transitions as the city's endeavours have been translated around the globe.

As the work of decarbonising Malmö shifted from the terrain of Western Harbour, so too do the entities enrolled and the matter of design. As Hyllie has become a target for intervention, the village-like qualities of Western Harbour have given way to more explicitly low carbon terms through 'smart' urban development. Here, making the pathway visible has involved explicitly connecting an aesthetic of modern commercial design – shopping centres, transit, and office development together with housing – with the notion of a C21st technologically-enabled system of providing energy and other services. The comprehensive plan for Malmö, adopted by the city council in May 2014, emphasize the need to be both 'attractive' and 'sustainable', and how this should be realised through creating a mixed-function dense, green and close city (Malmö 2014). At Hyllie, too, iconic symbols have also been critical. Making the junctures that comprise decarbonisation pathways legible for navigation has involved various techniques of rendering projected intentions for Malmö's future visible (see Figure 1). These layered practices of visibility have not involved the determination of a single vision either from a singular process of planning or through forms of community and stakeholder engagement, but have been partial, incremental and emergent. Rather than "being a synoptic vision emanating from a controlling center" legibility is a cautious and multi-step process, incorporating varying degrees of uncertainty and reflexivity" (Lee 2013: 150).

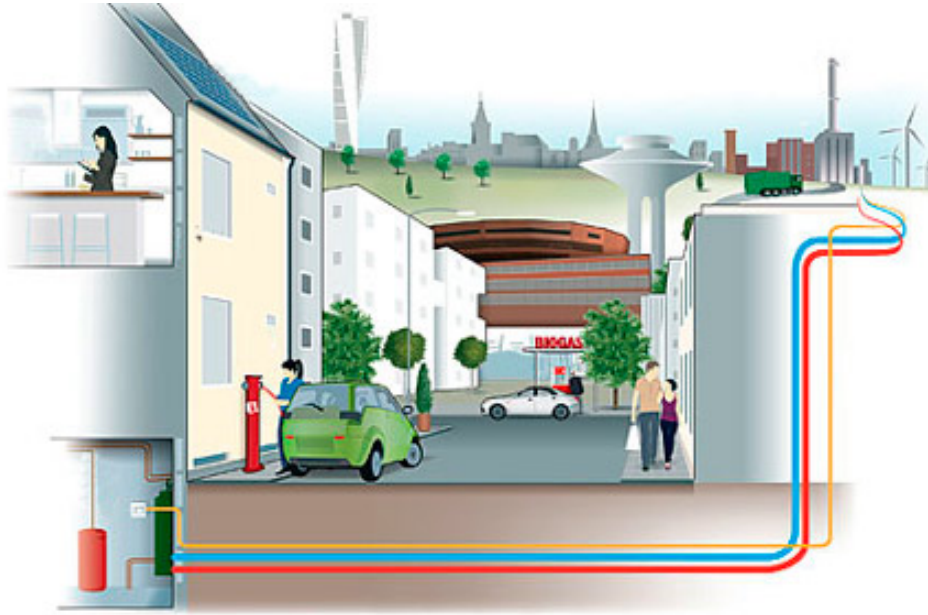


Figure 1: Hyllie testing ground for new technology, accessed sept 12, 2016,
<http://www.hyllie.com/artikelarkiv/hyllie-testing-ground-for-new-technology.aspx>

3.2 Demonstration

In Malmö, the political work of navigating decarbonisation relied not only on matters of legibility but on practices most commonly found in what Bennett (1988) has termed the “exhibitionary complex” – institutions of display, such as museums, expositions, shopping malls and the like as well as “the handbooks, programmes, newspaper reports and catalogues through which the knowledge associated with exhibitions is circulated and supported” (Whitehead 2008: 69). For Bennett, exhibitions are intriguing because they rely not only on techniques of codification (which serve to make things legible), but on techniques which orientate subjects such that they also become part of how the stories of, in this case, low carbon futures, are told. Exhibitions create a space not only for the public at large but for the public in particular: of what it means to participate in the public realm (Whitehead 2008). Whilst the formal institutions which comprised the exhibitionary complex of the C19th and early C20th are absent from the configuration of low carbon pathways, we find a parallel in the vast array of practices aimed at *demonstrating* how low carbon serve to both enact and engender new socio-material relations and subjectivities. Here too politics is conducted through socio-material relations and power immanent to these configurations.

Such forms of low carbon demonstration have been particularly evident around housing and the home as a site within which new ways of living are imagined in a low carbon world (Dowling et al. 2016). In the UK, the emergence of low carbon housing has been critically associated with demonstration projects that have gathered significant momentum within the policy sphere, with research suggesting that “the material

existence of the low energy housing is a critical reason why policy makers wish to be associated with it, because it is proof that the ideas and technologies embedded within the dwellings work, thereby giving instant credibility to what otherwise may be dismissed as rhetoric" (Lovell 2007: 2511). We regard demonstration projects, and the exhibitionary complex of which they are part, as a form of what Deville et al. (2014) term "concrete governmentality", forms of governmental technique and practice through which agencies literally set particular socio-material configurations in stone, both to signify their intentions but also as a means through which subjects come to govern themselves in relation to new socio-material orders. This work is particularly evident in relation to the Bo01 housing exhibition, designed explicitly to demonstrate that a different Malmö was possible. As Malmö's previous planning director put it, "you couldn't do it in the whole town so this would be the symbol of the new Malmö" (*N.N. Director of the city planning office 2014*). The fact that Bo01 became crafted as an environmental project was not primarily a result of the requirements of the funding through which it was created. Rather, sustainability emerged from the travelling of pioneering ideas and personnel from Hammarby Sjöstad, which was included in Stockholm's bid for the 2004 Olympic Games, and the ambition of Malmö to be a forerunner, a city of the future which in turn meant that it had to both exceed this benchmark and also demonstrate that its ambition could be made concrete. Developers interested in getting access to this iconic site had to comply with a detailed set of environmental requirements, and they had to calculate the environmental performance of the buildings using the provided tool.

While the exhibition was a particular moment, demonstrating is an on-going process. When the company that ran the BO01 exhibition went bankrupt on the day it closed, to public outcry, the organizational momentum appeared to evaporate. Yet the demonstration stood, carrying on a socio-material momentum and the work of navigating the city of the future. As Eva Dalman (a member of the urban planning team at Malmö during this period) wrote: "the city-district was still standing and started the same day to live its real life as a dynamic and progressive part of the urban village Malmö" (Dalman and Persson 2005: 14). The practice of demonstrating has since continued through the award of prizes, and the number of international delegations that come to the city. Demonstration enables fragments of a low carbon transition to travel through the city, navigating a pathway by making connections and enrolling new sites into the decarbonised urban assemblage. For example, the demonstration house 'Hållbarheten', an eight multi family dwelling and apartment building run by the Energy Company Eon, in Western Harbour, has served as an important mediator, carrying ideals of the low carbon home and family across the city. The house, which employs a variety of heating solutions including DH, Solar PV, Biogas and Heat pumps, allow the residents to produce their own energy, monitor and control their energy consumption. Residents have access to electric cars, bikes, vespas, but also an outside swimming pool to reduce the demand for travelling on vacation. The building is a 'smart-house' model where every apartment has over 50 measuring points, continuously supplying information about temperature and energy usage with respect to both heating and electricity including a number of household appliances such as lighting or kitchen equipment. Deliberately designed for a wide audience, key imaginaries of low carbon life at Hållbarheten enable decarbonisation to connect with Hyllie. As climate smart Hyllie comes to be configured and decarbonisation pathways unfold, its demonstration in various manifestation (images, folders, slide-shows, film-clips, walking tours) provides a means through which forms of the future can be navigated in the present as new junctures for intervention emerge. The new 'Kretseum' in

Hyllie is an education centre on circularity focussing on how water, waste and energy can be managed in a sustainable way. The exhibition (city model, activity stations and large screenings) allows visitors to imagine a travel through the city and explore and enjoy the everyday of the sustainable city. One should keep in mind however, the precarious relationship between Malmö municipality and Eon. From 1990s to 2008 GHGs emissions declined by almost 100 000 tonnes despite a population and GDP increase. However, after E.ON opened Öresundsverket (a natural gas CHP plant) in 2009 GHG emissions rose by 84%, measured between 2008 and 2010. Lenhart et al (2014), emphasize that Malmö municipality has no legal mandate to force E.ON to adopt renewable energy fuel types such as biogas since energy security is a question of national interest, which supersedes municipal authority. Today, Öresundsverket is transferred to Uniper and is not in use.

3.3 Bringing into Agreement

Much of the scholarship on transitions has emphasised how innovations or niche spaces might “breakthrough” existing regimes to transform the socio-technical provision of infrastructure and services. Yet this emphasis on rupture negates much of the work in science and technology studies that draws attention to how governing is enabled through bringing things into agreement such that new socio-technical orders are forged and material/capital flows are realigned. The work of bringing things together is a central if often underplayed aspect of governmental programmes and the working of power (Bulkeley 2016; Li 2009; McGuirk et al. 2016). Rather than being a straightforward matter of imposing political will through the force of power or ideas, such political work is often described as a delicate art of bricolage, of the piecing together of things such that new configurations and ways of ordering socio-technical relations are possible. McKenzie and Pardo-Guerra (2014: 157) suggest that successful innovation “is nearly always bricolage: the creative, ad hoc re-use of existing resources (ideas and other cultural resources as well as artefacts), not the mechanical implementation of a grand plan”. Miller and Rose argue that such forms of bricolage take place through translation operating via “a delicate affiliation of a loose assemblage of agents and agencies into a functioning network” such that actors come to convince one another that “each can solve their difficulties or achieve their ends by joining forces or working along the same lines”. Translation requires that entities are brought into agreement as “new objects are created out of the combinations of old elements, creating a chain of equivalences that compound different logics upon each other.” (Lee 2013: 149-150). Such logics and practices come undone where the entities required to come into assembly are unable to be held in relation to one another, such that the new low carbon pathways they promise cannot be realised (Hébert 2014). Forging agreement is therefore central to the ways in which power operates, not through force or the mobilisation of resources, but through creating differential capacities through which particular socio-material junctures are configured and the possibilities (and impossibilities) of the urban milieu (re)drawn.

The practice of bringing into agreement has been pivotal to the ways in which decarbonisation pathways are navigated through Malmö. The Western Harbour district started with the design of a “quality agreement” that made environmental performance mandatory. Having witnessed the problems of insisting on sustainability criteria being applied after the fact at the then flagship development “Hammarby

Sjöstad” in Stockholm, those involved in the Western Harbour made the environmental program part of the mandatory quality program to be negotiated and agreed up front. As one senior planner recalls “I tried to correct the mistakes I made in Stockholm. We took most of the negotiations before signing the contracts, which made the process afterwards much easier and better” (Edelstam 2014). The quality programme functioned as an “obligatory passage point” since the developers had to comply with the high environmental standards if they were to acquire the right to build there. Hence, the value of the land and the sustainability value developed in tandem. The quality programme translated one thing into the other. In the Western Harbour the City of Malmö has facilitated a “building and living dialogue” where “expectations are clear from the start and partners learn together how best to incorporate sustainability in the built environment” (Application for Habitat Scroll of Honour Award Malmö, Sweden). Both the use of mandatory standards and dialogues serve to align different interests and entities with one another around the emergence of decarbonisation. However, this is a precarious achievement, open to continual challenge as the municipality finds itself without the direct power to determine the outcomes of urban development (Smedby and Neij 2013: 154).

Holgersson (2014), who examines how the economic crises of 2008 affected Malmö, show that these processes are not smooth. At ‘Fullriggaren’, in the Western Harbor, twelve developers built (2009-2013) 634 apartments as well as office spaces, kindergarten and parking garage. During the onset of the crisis the municipality still owned the land and the pricing of the land was agreed with the developers. But the crises led developers to demand renegotiation and lower prices, which they were granted. This acquiescence on the part of the municipality confirms the municipal policy of continuing housing production at all costs. Less than two years following the crisis, prices returned to the pre-crisis levels, which was met with varying afterthoughts from the municipal authorities. Holgersen concludes that the crisis revealed how urban policy in Malmö was and remains immersed in a logic of pragmatism, which for all it’s flexibility did not respond to the crisis through radical transformation but rather through a reiteration of the institutionalized approach from prior the crisis of the 1990s.

Despite the setbacks experienced, the practice of bringing low carbon pathways into agreement has continued to be central to the ways in which low carbon transitions have been pursued in the city. Following a renewal of the ambition for Malmö to be an ecometropole in the late 2000s with the emergence of Hyllie as the newest site for urban development, a Climate Contract was signed in 2011 between the municipality, energy and water companies. The Climate Contract is a means through which to bring into agreement the various elements that comprise urban development into a configuration that could realise “the Öresund region’s most climate-smart city district and a global benchmark for sustainable urban development.” (Climate Contract 2011: 2). The Climate Contract was seen by those involved to provide a useful umbrella where increased use of renewables, energy efficiency and the delivery of a “smart city” provided the end game for the Hyllie development (Örtenvik 2014). It provides a means through which the diverse entities and elements involved in its realisation can be held together through a logic and practice of equivalence, such that the goals of one are built around and through the goals of another, and the various different material systems in the city come to accord with one another (Örtenvik 2014). Yet here too there is overflow. Real estate developers fail to comply with the requirements to drill boreholes to access the aquifers through which heating and cooling will be provided. Householders

wanted different kinds of control over their own energy and water systems. As new frictions emerge in the low carbon city, decarbonisation pathways are once more on the move. The new Swedish national building code is changing the game for Malmö. Technical requirements can no longer be coupled to land allocation agreements. Hence, the new Environmental Programme Hyllie (2015), which describes Hyllie as Malmö's large-scale pilot for sustainability, does not put forward mandatory requirements but clarifies ambitions for Hyllie (its environmental objectives) and establish new processes of dialogue with the developers.

4. CONCLUSIONS

As climate politics multiples, from the UN to the urban and the everyday, stretching across different sites and socio-technical systems, much work in the policy sciences has been undertaken to understand the nature of climate change governance in terms of the new agents of change involved and the structures that impede low-carbon transitions. Yet to date this work has had little engagement with the growing field of transition studies, within which significant efforts to comprehend and direct socio-technical transitions is taking place. Within transition studies, recent efforts have sought to bring questions of power and politics to the fore, yet this work has largely neglected the diversity of approaches to power that have emerged within the wider study of climate change governance over the past two decades. In this paper, we have sought to bring critical political geographical perspectives to bear on the question of the politics of decarbonisation as a means through which to navigate this terrain. We have suggested that work on the politics of transitions has so far been limited by its rather incongruous focus on power as a capacity held by individual agents on the basis of the resources which they command. This has led to a neglect of the material and relational aspects of socio-technical systems and their dynamics. In our view, structural and productive accounts of power provide an opening through which to think through power in material and relational ways that in turn enables us to imagine and analyse transition pathways not as unidirectional but as provisional, unfolding and drawing attention to the critical work of how transitions are enacted and contested. We find with Jensen et al. (2015) that the political geography of decarbonisation pathways is not directional, but navigational. This is not to say that it is without strategic intention or the operation of power, rather it is to suggest that if power is an immanent property of socio-material configurations, it is always in the making and subject to contest and reversal.

In the case of Malmö we find three practices through which navigational politics of pathways are enacted. First, *legibility* is a calculative or aesthetic way of coding, representing and knowing a domain, thus making it legible for government to operate. Planners' circulation of early drawings, sketching out the Western Harbour with enough details, gave the vision of a different future a contemporary presence. The Bo01 housing exhibition made visible a range of socio-material proxies for sustainability and put forward an urban aesthetic heralding an aspirational low carbon lifestyle. When decarbonisation moved to Hyllie, an aesthetic of 'smart urban development' took shape, combining commercial design with automated and flexible provisions of energy and other services. Turning Torso, a nail in the coffin of the old shipyard, attempts to make the arrival of the new Malmö visible from a distance and enables it to reach a global audience. Second, *demonstration* is about putting particular socio-material relations (e.g. housing,

mobility, energy provision, shopping) in place enrolling subjects in the narrative of a low carbon transition. Bo01, an 'exhibitionary complex' bringing together planners, developers, architects and the public, put a different Malmö on momentary display, but demonstration requires on-going work. E.ON's house 'Hållbarheten' provides an imaginary of low carbon life and enables decarbonisation to travel across the city to Hyllie, establishing a new juncture to be navigated through climate-smart urbanism. Third, bringing into *agreement* is about piecing together a bricolage of diverse entities — thereby enabling socio-material relations to reconfigure. The quality contract for Western Harbour, and the Climate Contract for Hyllie, are key examples of how Malmö's low carbon pathway has been assembled and translated between diverse actors and how each agreement installs a particular logic enabling decarbonisation to be navigated.

Researching pathways to decarbonisation in Malmö reveals that instabilities and fluidities matter. Seeds of decarbonisation, if planted on hard or fallow land, will find it difficult to grow. But at the junctures, where the established order and identity of the urban fabric has become disturbed and destabilised, decarbonisation can take root and find new alignments. Transitions to decarbonisation require that the socio-material infrastructures of high carbon urbanism are *undone*, as much as new technical and social innovations need to emerge. We find that the political geography of decarbonisation pathways are not a matter of scaling up from the niche so much as a matter of inclusion, where more and different parts of (in this case) the urban milieu become entrained into the low carbon transition. Decarbonisation is hence not a particular destination, but rather an indeterminate achievement. There were, of course, many uneven dimensions to the early Western Harbour development, but already after only a few years the beachfront had become much more integrated with the city. City planners needed to adapt the beachfront and make it public and accessible. Social implications of decarbonisation are not set in stone, but require attention. In Malmö, the comprehensive plan from 2014 underscore that development must be about creating a socially balanced city with good living conditions for all its citizens (Malmö 2014: 3). It remains to be seen to what extent this will happen in the years to come. Like many utopias, the original Bo01 site set its example by being different, but that does not mean that such urban development can, or should, scale in any simple terms, nor that the experimentation was not worth the effort. The pathway to decarbonisation emerges as new connections and junctures are formed, overflowing existing socio-material configurations and finding expression in a diverse array of sites and domains.

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¹ The city has been awarded amongst others: 3rd place in Green Uptown Magazine, First place in EU Commission RegioStars Awards, Idébanken award for sustainable development, Earth Hour Capital 2011 by WWF, Winner of the UN-World Habitat Awards, finalist in 2012 & 2013 for the EU Green Capital award, The Chinese prize of Friendship City Cooperation for it's cooperation with Tangshan, and the 2009 "Certificate of Merit for Superior Achievement in District Energy" in the "District Energy Climate Awards.

² The EU LIFE program (2014-2020) supported GreenClimeAdapt (climate adaptation strategies) and BioGasSys (large and small scale biogas production). Malmö is funded by "BUILDSMART" & "VERY LOW ENERGY BUILDINGS", which incorporate test and demonstration subprojects amongst others the Malmö Live concert and conference centre. Malmö is working on E-Mission (EV Development), BUCEFALOS (Aquatic Biomass etc) and hosted a EU cooperative project with the Region of Skåne titled CLIRE (demonstration projects for climate friendly healthcare). Two major EU programs that have proved important in the context of Malmö's climate work are Civitas (Clean and Better Transport in Cities) and most especially the Concerto program in which Malmö participates as one partner within Act 2 (2006-2012), which has the aim of mainstreaming energy efficient building standards and RE systems across Europe. Malmö is a signatory to the Covenant of Mayors which obligates it to lower emissions by 20% to 2020. The City is also a signatory to Eurocities Climate Declaration and the Green Digital Charter.

³ Bo01 was originally planned to take place south of Malmö, in Limhamn on a small island, The inspiration came from Eco-Villages such as Tuggelite (Karlstad), Solbyn (Dalby), Toarp (Oxie) and Understenshöjden (Stockholm) (Dalman and Persson, 2005).